

Combined results of searches for first generation leptoquarks

Simona Rolli

TUFTS University

Abstract

We report on the combination of the searches for first generation scalar leptoquarks performed using 72 pb^{-1} of Run II data. First we combine the results of the searches in the channels $eejj^{[1]}$ and $evjj^{[2]}$ are combined obtaining an upper limit on the production cross section as a function of the leptoquark mass and the branching ratio $\beta = \text{Br}(\text{LQ} \rightarrow e q)$ which gives competitive result for $\beta > 0.3$. We then combine the above 2 channels with the $vvjj^{[3]}$ channel result and obtain better limit than the individual channels in the low β region ($\beta < 0.5$).

By comparison with the theoretical calculations^[4] of the cross section we set a lower limit on $m(\text{LQ})$ as a function of β .

Introduction

Searches for pair produced first generation LQ have been performed using the first RunII data in three channels:

$eejj$ – This search gives an upper limit optimal for a branching ratio $\beta = \text{Br}(\text{LQ} \rightarrow e q) = 1$;

$evjj$ – This search gives the highest limit optimal for a branching ratio $\beta = \text{Br}(\text{LQ} \rightarrow e q) = 0.5$;

$vvjj$ – The optimal limit is obtained for $\beta = \text{Br}(\text{LQ} \rightarrow e q) = 0.0$.

In Figure 1 the exclusion regions as function of β obtained from the single channel analysis $eejj$ and $evjj$.

This note presents 2 results: the combination of the 2 channels $eejj$ and $evjj$, and the combination of all three possible decay channels. The results are combined using a procedure based on a Bayesian approach^[5], which takes into account the correlations in the systematic uncertainties.

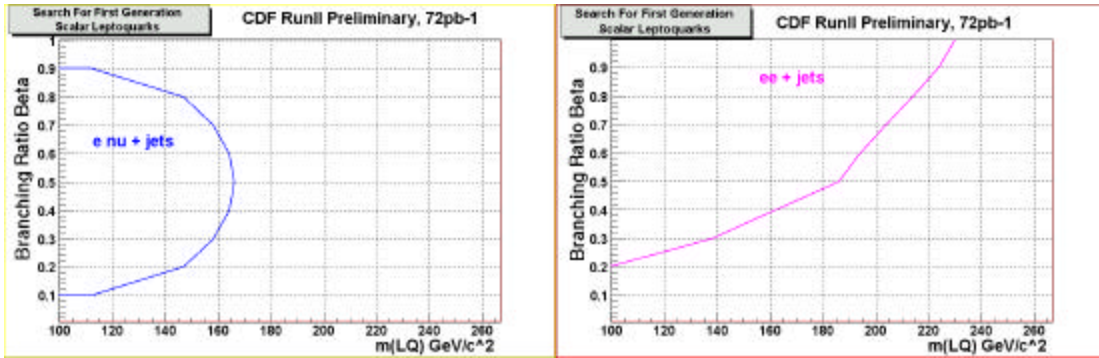


Figure 1 – Exclusion regions as a function of $Br(LQ @ eq)$ obtained from the single $e\nu jj$ and $eejj$ channels. The areas at the left of the curves are excluded at 95% CL.

Method

To calculate the limits combining all the available leptoquarks decay channels we have used a Bayesian approach. A joint likelihood has been formed from the product of the individual channels likelihood. For each mass we simulated 10K pseudo-experiments, smearing the calculated number of background events and the estimated number of signal events by their respective total uncertainties. The searches in the $eejj$ and $evjj$ channel use common criteria and sometime apply the same kind of requirements (for example on the tight electron identification) so the uncertainties in the acceptances have been considered completely correlated (which gives the most conservative limit). When calculating the limit combination including also the $vvjj$ channel the uncertainties in the acceptances have been considered uncorrelated.

Results

The results of the combination for first generation scalar leptoquarks are presented in Figure 2, for the 2 cases:

- ee jj and evjj combination
- eejj, evjj, vvjj combination

In Table 3 the combined 95% limits on the signal events and corresponding cross section limits for different LQ masses and for some values of β . The combination is performed also for $\beta=1$, since the evjj analysis has a non-zero efficiency for di-electron events, when one of the electrons is not in the detector acceptance.

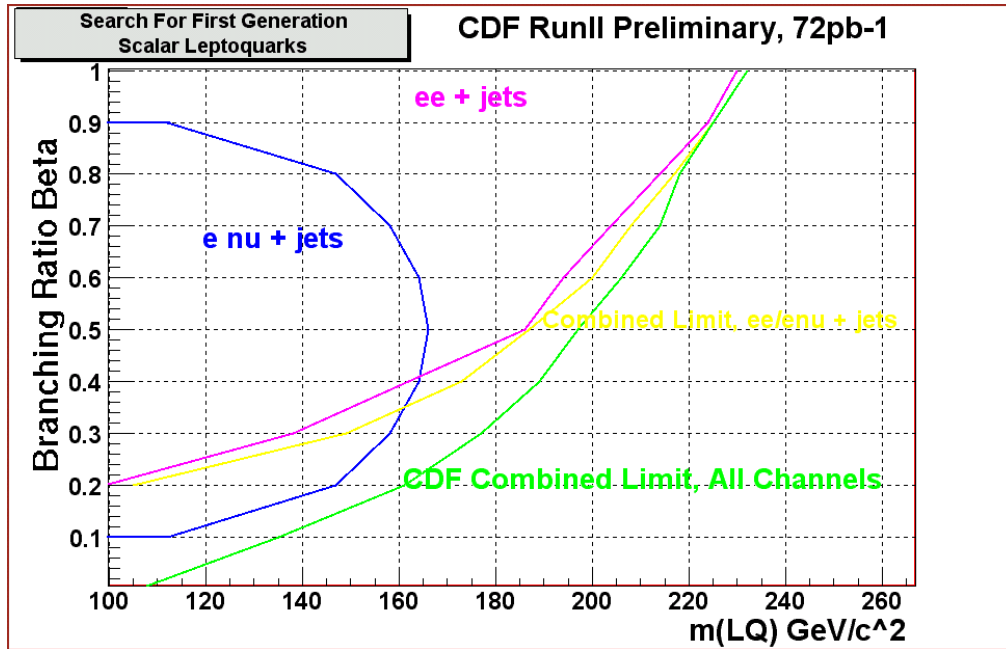


Figure 2 – Exclusion regions as a function of $Br(LQ @ eq)$ obtained from the single $e \nu jj$ and $eejj$ channels, their combination (yellow curve) and combination with the $eejj$ channel (green curve). The areas at the left of the curves are excluded at 95%CL.

M(LQ) GeV/c ²	$\beta=0.2$	$\beta=0.5$	$\beta=1.0$
	σ_{95} (pb)	σ_{95} (pb)	σ_{95} (pb)
100	4.5	1.8	0.8
140	1.3	0.5	0.2
160	0.9	0.3	0.12
200	0.7	0.24	0.098
220	0.6	0.22	0.091
240	0.5	0.20	0.083

Table 1 – 95% CL combined cross section limits for different values of β , obtained from the combination of only $eejj$ and $e\bar{n}jj$ channels (case mass = 220, 240 GeV/c²) and from all three $eejj$, $e\bar{n}jj$ and $\bar{n}\bar{n}jj$ channels (mass < 220 GeV/c²)

Conclusions

We have performed the combination of all the CDF searches for first generation scalar leptoquarks using Run II data. The results are presented for the 2 channels $eejj$ and $e\bar{v}jj$ combination, and the combination of all three possible decay channels. The results are combined using a procedure based on a Bayesian approach which takes into account the correlations in the systematic uncertainties.

We set 95% CL lower limit for scalar first generation leptoquarks at 161 GeV/c² ($\beta = 0.2$), 197 GeV/c² ($\beta = 0.5$) and 232 GeV/c² ($\beta = 1.0$).

Acknowledgements

I want to thank Lorenzo Moneta for providing me with the code necessary to perform the limit combination. I also thank Federica Strumia and Lorenzo for useful discussion about the combination procedure.

References

- 1) Search for first generation leptoquarks pair production in $eejj$, S. Rolli CDF/ANAL/EXOTIC/CDFR/6338, March 2003
- 2) Search for first generation leptoquarks pair production in $e\bar{v}jj$, S. Rolli CDF/ANAL/EXOTIC/CDFR/6436, June 2003
- 3) Search for First-Generation Leptoquarks in the Jets and Missing Transverse Energy Topology. D. Acosta, K. Konigsberg, A. Moorhead, D. Tsybychev, S.M. Wang. CDF/ANAL/EXOTIC/CDFR/6383
- 4) Pair Production of scalar LeptoQuarks at the TeVatron, M. Kramer et al., Phys Rev Lett 79, 341, 1997.

- 5) Combined Results of Searches for Second Generation Leptoquarks, Lorenzo Moneta. CDF/ANAL/EXOTIC/PUBLIC/5790